

97/02193 Assessment of a multistage underwater vehicle concept using a fossil-fueled Stirling engine

Reader, G. T. and Potter, I. J. *PD (Am. Soc. Mech. Eng.)*, 1995, 66, (Emerging Energy Technology 1995), 59–66.

Due to its inherent closed-cycle operation, the Stirling Engine can be readily modified to work in an airless environment even if the primary source of energy is a fossil fuel. Thus, Stirling engines are well suited for use in the underwater environment and have been operated successfully in manned military submarines since the early 1980s. In recent years fossil fueled Stirling systems have been also proposed for use in small unmanned underwater vehicles (UUVs). However, in this case the need to carry an onboard oxygen supply in a very confined space has presented a number of design difficulties. These are identified in the paper and a possible solution is proposed. This concerns providing the oxidant supply to the engine by the membrane extraction of dissolved oxygen from seawater and/or the use of disposable fuel/oxidant pods.

97/02194 Biomass-gasifier/aeroderivative gas turbine combined cycles: Part B—performance calculations and economic assessment

Consonni, S. and Larson, E. D. *J. Eng. Gas Turbines Power*, 1996, 118, (3), 516–525.

The results of detailed design-point performance calculations for several biomass-integrated gasifier/gas turbine (BIG/GT) combined cycle configurations are reported. Emphasis is given to systems now being proposed for commercial installation in the 25–30 MWe power output range. Three different gasifier designs are considered: (1) air-blown pressurized fluidized-bed gasification, (2) air-blown near-atmospheric pressure fluidized-bed gasification, (3) near-atmospheric pressure indirectly heated fluidized-bed gasification. Advanced combined cycle configurations (including intercooling) with outputs 22–75 MW are also explored. The paper also presents an economical assessment, based on preliminary capital cost estimates for BIG/GT combined cycles and expected biomass costs in several regions of the world.

97/02195 The Cascaded Humidified Advanced Turbine (CHAT)

Nakhmkin, M. *et al.* *J. Eng. Gas Turbines Power*, 1996, 118, (3), 565–571. The Cascaded Humidified Advanced Turbine (CHAT) plant is a gas turbine based power generation plant utilizing intercooling, reheat, and humidification. It is based upon the integration of an existing heavy duty gas turbine with an additional shaft comprising industrial compressors and a high pressure expander. CHAT capitalizes on the latest proven gas turbine technology, which, combined with a sophisticated thermal cycle configuration, results in substantial improvement in gas turbine efficiency, compared to a simple cycle, while still maintaining typical advantages and merits of a combustion turbine plant. Compared to a combined cycle plant, the CHAT plant offers lower emissions (due to air humidification) and other significant operating advantages with regard to start-up time and costs, better efficiency at part load, lower power degradation at higher ambient temperatures, and simpler operations and maintenance due to elimination of the complexities and costs associated with steam production. The CHAT plant also integrates very effectively with coal gasification and particularly well with the water quench design.

97/02196 Combustion of low heating value gas in a gas turbine

Kelsall, G. and Cannon, M. *VTT Symp.*, 1996, 164, (Power Production from Biomass II with Special Emphasis on Gasification and Pyrolysis R&DD), 109–126.

A brief overview of the air blown gasification cycle (ABGC) development initiative is presented and the general requirements for a gas turbine operating within such a cycle are discussed. In addition, it reports full combustor performance results for the second phase of turbine combustor development and discusses the rationale for the progressive design modifications made within that program. The strategy for the further development of the combustor to burn low calorific value fuel gas with low conversion of fuel-bound nitrogen to NO_x is also presented.

97/02197 Development of 12% Cr steel rotor shaft for ultra-super critical pressure steam turbine

Tsuchiyama, T. *et al.* *Sokeizai* 1996, 37(7), 9–13. (In Japanese)

Twelve percent Cr steel of excellent hot rupture strength was developed for use as rotor shafts in order to improve the thermal efficiency of coal-fired dynamos. The bearing area of the rotor shaft is overlay-welded, cold rolled and stress relieved to convert the residual tensile stress into the residual compression stress for a highly reliable structure.

97/02198 Effect of turbine-blade cooling on the HAT (humid air turbine) cycle

Gallo, W. L. R. *et al.* *Energy*, April 1997, 22, (4), 375–380.

Presents a discussion of the effects of turbine-blade cooling on HAT-cycle performance.

97/02199 An evaluation of the economics of fuel cells in urban buses

Hormandinger, G. and Lucas, N. J. D. *International Journal of Energy Research*, 1997, 21, (6), 495–526.

The fuel cell is a potential clean source of on-board electric power in a vehicle. Despite being less known and less advanced than batteries, fuel cells could provide the power for a novel generation of non-polluting vehicles. Fuel cell technology is currently entering the stage of commercialization, therefore it is now appropriate to assess its economic potential in the field of transport. A model was set up of a fleet of urban buses, widely regarded as one of the earliest applications of fuel cells in transport. The paper concludes that in order to succeed in the marketplace, the principal task for the developers of fuel cells is a further reduction of the cost.

97/02200 Experience with unconventional gas turbine fuels

Mukherjee, Dr. D. K. *VTT Symp.*, 1996, 164, (Power Production from Biomass II with Special Emphasis on Gasification and Pyrolysis R&DD), 93–107.

The Ban Shan Iron and Steel Company in Shanghai recently placed an order with Kawasaki Heavy Industries, Japan, to supply a combined-cycle power plant. The plant is to employ ABB's GT 11N2 with a combustor modified to burn blast furnace gas. Recent tests have confirmed the burner design. The same basic combustor concept can also be used for the low-British thermal unit gas derived from air-blown gasification processes. ABB is also participating in the API project: a refinery-residual gasification combined-cycle plant in Italy. The GT 13E2 gas turbine employs MBtu EV burners that have been successfully tested under full operating conditions. ABB's vast experience in burning blast furnace gas (21 plants built during the 1950s and 1960s), residuals, crude, and coal in various gas turbine applications is an important asset for building such power plants. This paper discusses some of the experience gained in such plants.

97/02201 An experimental characterization of the formation of pollutants in DI diesel engines burning oxygenated synthetic fuels

Beatrice, C. *et al.* *IMECH Conf. Trans.*, 1996, (5, Application of Powertrain and Fuel Technologies to Meet Emissions Standards), 261–272.

Further development of the combustion system of the direct injection diesel engine is required if it is to meet the regulations scheduled for the end of the century. This study aims to investigate the role of some oxygenated synthetic fuels in a conventional technological DI diesel engine, as regards pollutant formation. The experimental technique adopted to investigate the pollutants formation is the two colors pyrometry. The experimental tests have demonstrated that the oxygen content of the fuel has a strong influence on soot formation process. Simultaneously, these fuels present very high cetane numbers, which leads to a reduction of the NO_x , HC and CO emissions. Aldehydes emissions are also relatively low. To confirm the main trends observed in the research engine, a comparison is presented between regulated emissions between pentyl ether, ethylene glycol di-Me ether, and two reformulated diesel fuels of a modern four cylinders DI diesel engine for passenger car application.

97/02202 Fuel cells for transport: can the promise be fulfilled? Technical requirements and demands from customers

Klaiber, T. *Journal of Power Sources*, 1996, 61, (1–2), 61–69.

The customer demands and technical requirements for vehicles that have an on-board methanol reformer and fuel cells are reported. The research concentrates on the technical developmental risks which include minimizing volume, reducing weight and, at the same time, improving efficiency and system dynamics. The greatest hindrance will be the price of the fuel cell. A possible progressive development of the number of fuel cell powered vehicles in conjunction with a reduction in costs will be discussed in the paper.

97/02203 Fuel-rich hydrogen-air combustion for a gas-turbine system without CO_2 emission

Noriyuki, K. *et al.* *Energy*, 1997, 22, (2/3), 189–197.

A proposal for a new and innovative gas-turbine system using fuel-rich hydrogen combustion is presented, called a chemical gas-turbine system. It involves a fuel-rich hydrogen air combustor as a major component. We have focused on a coaxial diffusion flame under normal pressure. Temperature profiles, gas compositions, and flame structures were measured using direct observations of OH radical emissions to investigate the effects of equivalence ratio and swirl number. The flames were shortened and NO_x emission decreased with swirling under fuel-rich conditions.

97/02204 High efficiency carbonate fuel cell/turbine hybrid power cycle

Steinfeld, G. *et al.* *Proc. Intersoc. Energy Convers. Eng. Conf.*, 1996, 31, 1123–1127.

This paper presents a hybrid power cycle which generates power at an LHV efficiency in excess of 70%. It includes an atmospheric pressure direct molten-carbonate fuel cell, a gas turbine, and a steam cycle. Simulation studies of a 200 MW plant with a hybrid power cycle showed an LHV efficiency of 72.6%. The hybrid cycle power output and efficiency are relatively insensitive to ambient temperature, compared to a gas turbine combined cycle. The NO_x emissions from the hybrid power cycle are 75% lower than the level from a combined cycle. A key technological requirement in the hybrid power cycle is the heat exchanger which transfers heat to the compressed air from a gas turbine. In the 200 MW plant studies,